Multi-model calibration and combination of seasonal sea surface temperature forecasts over three different tropical regions

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1. Introduction

- Seasonal prediction is probabilistic in nature
- Dynamical forecast systems have substantial systematic errors
- Important to quantify the main sources of uncertainty
  - Initial conditions ⟶ Ensemble forecast
  - Model inadequacy ⟶ Multi-model ensemble forecast

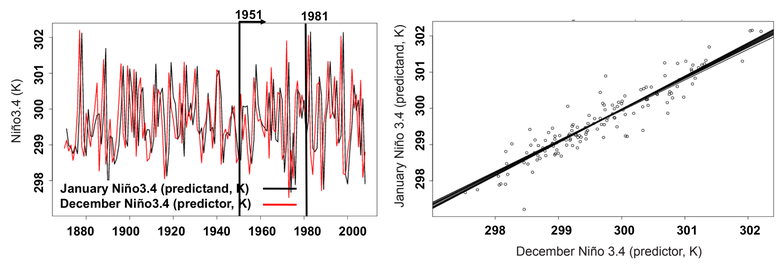
2. Objectives

- Combine ECMWF System 3 and NCEP CFSv2 using different methods. A statistical model based on lagged SST was also used.
- Forecast quality assessment for three tropical SST indices:
  - Niño3.4 SST index (170°W - 120°W, 5°S - 5°N)
  - Subtropical Northern Atlantic (SNA) SST index (55°W - 15°W, 5°N - 25°N)
  - Western Tropical Indian ocean (WTI) SST index (50°E - 70°E, 10°S - 10°N)

3. Forecast Systems

- ECMWF System 3
- NCEP CFSv2
- Statistical model
  - Simple Linear Regression ⟶ Lagged SST as predictor
  - First training period: 1951 - 1981, adding a new year at a time
  - Target period: 1982 - 2010

Observed HadISST Niño3.4 index



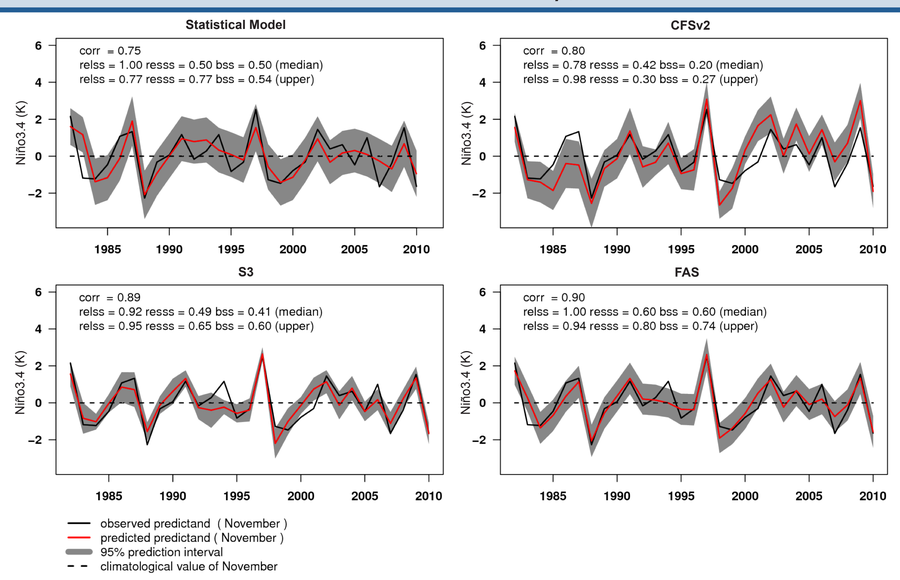
The statistical model takes advantage of Niño3.4 persistence. Other target months, for which persistence is not as strong as in boreal summer, give less skill. The statistical model was built in forecast mode, that is, only years prior to target year were used to estimate the regression coefficients.

4. Methods

- Simple Multi-Model (SMM)
- Multiple Linear Regression (MLR)
- Principal Component 1 regression (PC1)
- Principal Component Analysis regression (PCA)
- Forecast Assimilation - Climatology (FAC)
- Forecast Assimilation - Statistical (FAS)

5. Examples of Forecasts

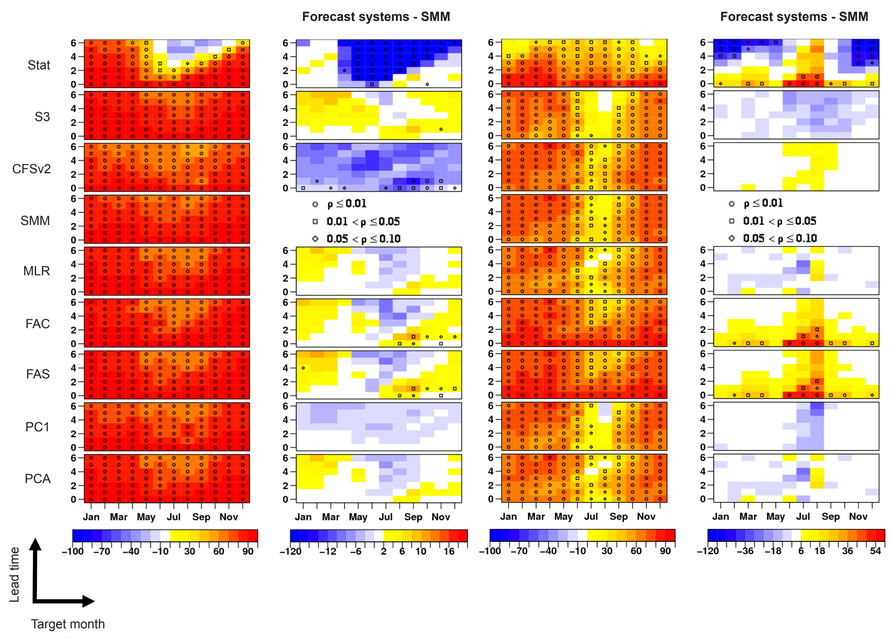
Niño3.4 forecasts for the target month of November and lead time 4 (start date in July)



FAS provides more reliable predictions than the other systems because the uncertainty grey bands contain additional information from the observation. FAS predictions also have improved resolution when compared to the other systems (see numbers on top left of each figure).

6. Forecast Quality Assessment

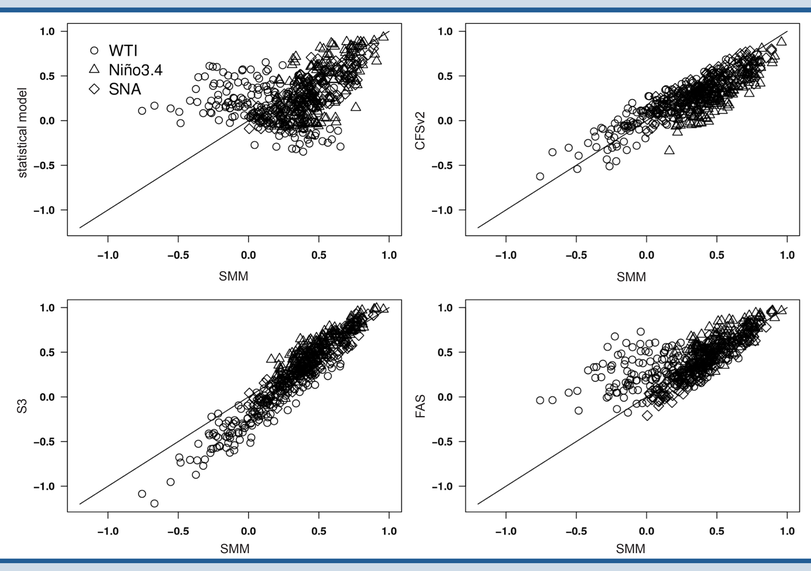
Ensemble-mean skill (Correlation coefficient)



The SMM outperforms the single forecast systems in terms of accuracy more often than not, but not always as in the case of the Niño3.4 index forecasts on which S3 performs better more often. The inclusion of the information from the statistical model could either increase or decrease the accuracy of the combination.

Probabilistic forecast quality (Brier skill score)

All aspects of the forecast: three SST indices, 12 target months, 7 lead times, two events (above the median and above the upper quartile)



The combination methods that take into account the information from the statistical model had better probabilistic forecasts than the other combination methods and the single forecast systems more often than not.

7. Conclusions

- Quantify the sources of forecast uncertainty (initial conditions and model inadequacy) is very important
- SMM outperforms single forecast systems more often than not
- SMM is a difficult benchmark to beat due to:
  - Short time series available
  - Small number of dynamical forecast systems
- FAS improved both accuracy and reliability

8. Future Work

This study will be extended to the spatial analysis of the monthly-mean two-meter temperature and precipitation predictions in the Mediterranean region.

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